IP-EFOY-GATEWAY
Technical Overview - EN

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1 Introduction

The IP-EFOY-GATEWAY serves for remote control of a single SFC EFOY PRO fuel cell over the TCP/IP protocol. At this the entire fuel cell parameter defined by the SFC EFOY PRO technical data sheet are readout continuously over the RS232 interface. These data sets are provided to the customer for control application in different formats.

- SNMP
- XML
- HTML web site
- Email
- TCP-UART-Bridge-Mode (direct EFOY Pro remote command line interface terminal)
- TCP socket services can be developed on request

Furthermore, the IP-EFOY-GATEWAY gives the customer the opportunity to set up/reconfigure the EFOY PRO fuel cell either within a local area network or over the internet by using the web site. There is no need for further software installation.

The customer benefits from a simple and intuitive web menu navigation to preconfigure the fuel cell ex ante or in a live running system.

However, the greatest benefit of the IP-EFOY-GATEWAY solution is that it makes it possible to give your EFOY PRO fuel cell an IP address and that it can be integrated in a given IP network very quickly without any limitations. From now on statically scheduled service tours are minimized and can be coordinated much better since EFOY PRO fuel cell's parameter/states may be retrieved from each location and 24 hours a day.

2 Firmware update description

2.1 V0.8.3

- Firmware supports now SFC EFOY PRO 800/800 DUO and 2400/2400DUO
- Dynamic web data update interval on the web site can be adapted

2.2 V0.7.1

- Firmware supports now SFC EFOY PRO v11.10 with CONFIG command adaptation, but also backward compatibility is assured

2.3 V0.6.7

- As default setting the IP-Address is bound over DHCP
- Additional EFOY data fields are read-out and displayed on the web site
  - Service fluid level
  - Temperature stack, fuel cell, heat exchanger
  - Connected fuel cell type (EFOY PRO 600 … 2200 XT)
  - Warranted operating hours (in charge mode) for the particular fuel cell
- Email Notification Report
  - If service fluid level <10%
  - If warranted operating hours (in charge mode) reached

3 Technical Data

Data	Range	Comment
Power consumption	~1W	
Input voltage range	8V - 42V	• Allowed with 12V/24V batteries • Power supply on terminal block and over EFOY PRO data interface as well
Ethernet		• 10/100BASE-T IEEE802.2 compatibility
RS232 (1 port)		• Communication EFOY PRO with 9600 Baud

Table 1: Electrical Data

Data	Range	Comment
Housing size (W x H x D)	105 mm x 33 mm x 102 mm	
Housing material	Aluminium(silver anodised)	
Weight	330g	
Options		

Table 2: Mechanical Data

Data	Range	Comment
Ambient temperature	-25 °C … +70 °C	

Table 3: Environment conditions

4 IP Configuration

The following 5 shows the default settings of the IP-EFOY-GATEWAY.

By pressing the „Default“ switch button 5 seconds (see Figure 1) you can restore the default setting.

DHCP	Enabled since firmware version v0.6.7
IP address	192.168.96.210
Subnet mask	255.255.255.0
Gateway	192.168.96.1
Primary DNS	192.168.96.1
Secondary DNS	0.0.0.0

Table 4: IP default settings

5 Description Periphery

5.1 Front panel

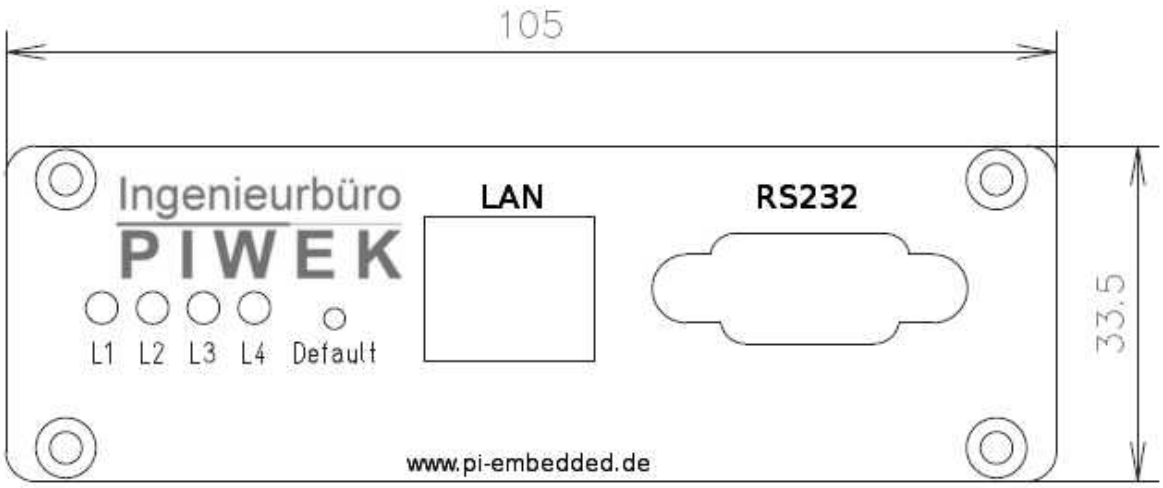

Figure 1: Front panel

L1	Power supply on
L2	1Hz heart beat, system
L3	Data communication EFOY Pro ↔ IP-EFOY-GATEWAY
L4	Not used
Default	Switch button must be pressed > 5 seconds, to restore default setting
RS232	Communication IP-EFOY-GATEWAY ↔ EFOY PRO • just use with appropriate adaptor (available on request in Cabel-Kit)
LAN	Ethernet 10/100BASE-T (cables available on request in Cabel-Kit)

Table 5: Description front panel

5.2 Back panel

Figure 2: Back panel

Ext. Power	External power supply 8-42V • Inverse-polarity protection • TVS Diode >54V • Power supply filter

Table 6: Description front panel

6 Supported Protocols

Protocol	Comment
HTTP	• Configuration • Fuel cell states
DCHP Client	• Automatic IP configuration
SNMP v2c	• Remote control EFOY PRO
SMTP	• Email notification service
Protocol stack EFOY PRO	• Communication with EFOY PRO over RS232
TCP-UART-BRIGE-MODE	• Remote communication with EFOY PRO over terminal command line interface
Socket Server Service	• Optional on request

Table 7: TCP/UDP Protocols

Protocol	Comment
Protocol stack EFOY PRO	• Communication with EFOY PRO over RS232

Table 8: Protocol RS232

7 EFOY PRO Compatibility

Fuel Cell	Comment
EFOY PRO 600/1600/2200/2200 XT	• Compatible with EFOY PRO versions equal or greater than QB date 2011-03-24
EFOY PRO 800/2400/DUO	• Compatible with EFOY PRO versions equal QB date 2012-11-11

Table 9: EFOY PRO compatibility

8 Getting started

Figure 3 depicts schematically the cabling diagram of the IP-EFOY-GATEWAY to other communication devices and EFOY PRO periphery.

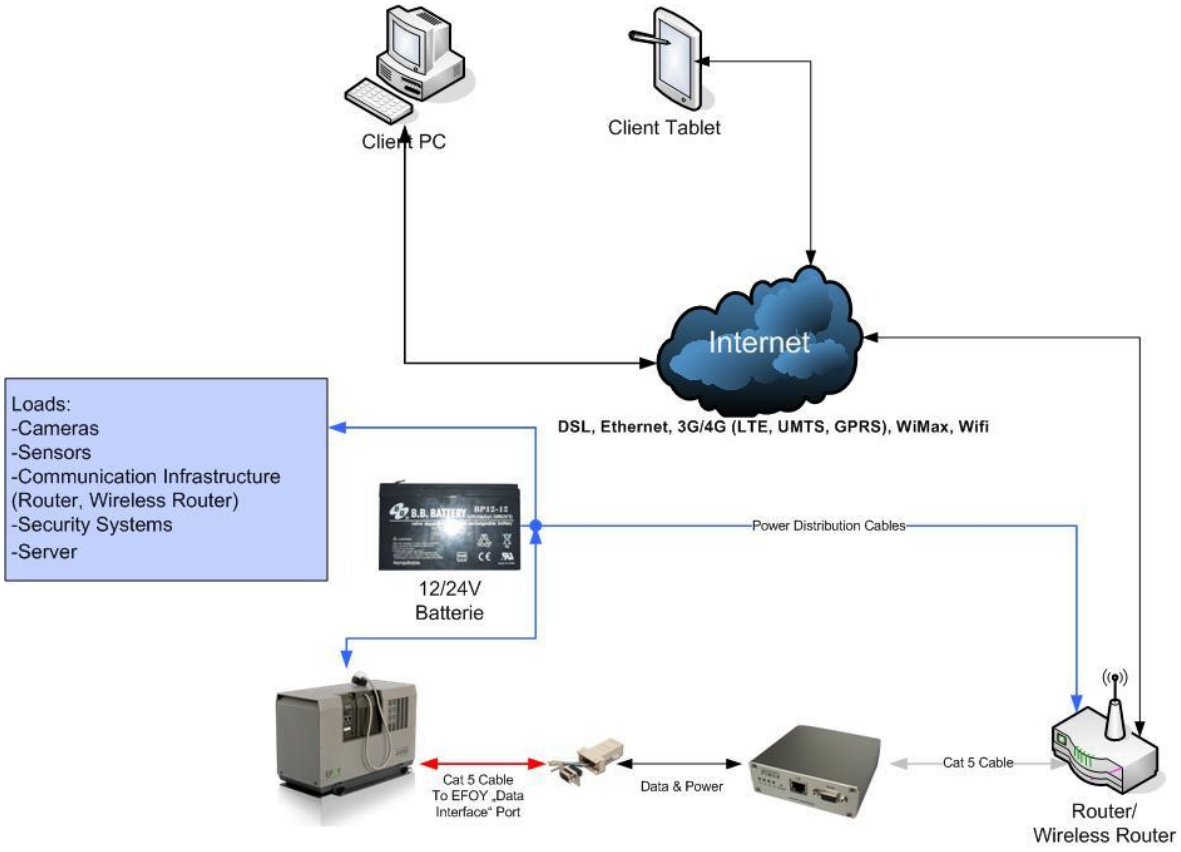

Figure 3: Schematic Installation

As a start please follow the following steps to set up the network configuration properly. The IP-EFOY-GATEWAY's default IP-Address is ***"192.168.96.210"***.

Use your browser on initial installation or after a default reset to access IP-EFOY-GATEWAY's web server. First you have to set up network settings to be conform with your local network.

1. Connect the IP-EFOY-GATEWAY RJ-45 interface labelled with ***"ETH"*** with the grey cable to your PC's network interface
2. Reconfigure the IP configuration under menu ***"Internet protocol version 4"*** of your PC's network interface and then press ***"properties"*** (see Figure 4)

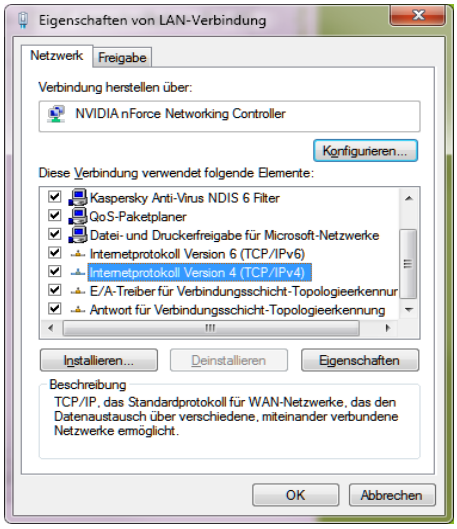

Figure 4: IP-Configuration Menu

3. Choose the following IP configuration for your PC (see Figure 5).

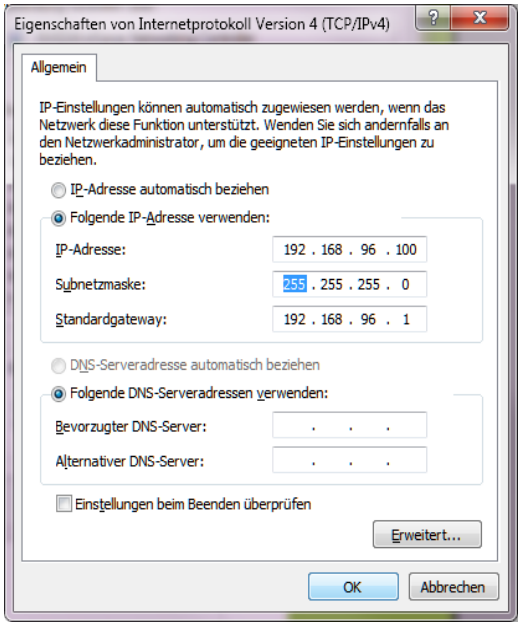
Eigenschaften von Internetprotokoll Version 4 (TCP/IPv4)
Allgemein
IP-Einstellungen können automatisch zugewiesen werden, wenn das Netzwerk diese Funktion unterstützt. Wenden Sie sich andernfalls an den Netzwerkadministrator, um die geeigneten IP-Einstellungen zu beziehen.
IP-Adresse automatisch beziehen
Folgende IP-Adresse verwenden:
IP-Adresse: 192 . 168 . 96 . 100
Subnetzmaske: 255 . 255 . 255 . 0
Standardgateway: 192 . 168 . 96 . 1
DNS-Serveradresse automatisch beziehen
Folgende DNS-Serveradressen verwenden:
Bevorzugter DNS-Server:
Alternativer DNS-Server:
Einstellungen beim Beenden überprüfen
Erweitert...
OK
Abbrechen

Figure 5: PC's static IP-Configuration

4. Open the browser and enter the default IP address of the IP-EFOY-GATEWAY (see Figure 7).

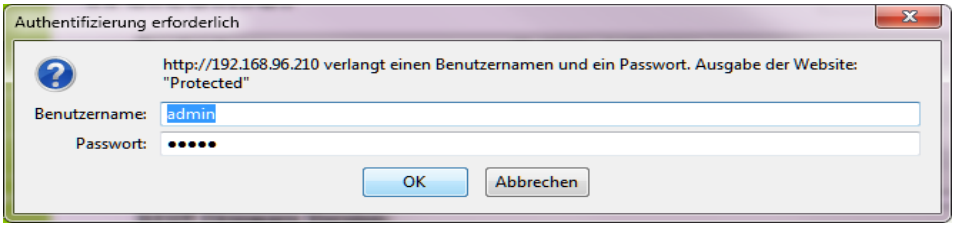

Figure 6: Login IP-EFOY-GATEWAY website

5. Choose menu item ***"IP"*** on the left of the website and enter the default login and password combination (see Figure 6 - Default user name: ***"admin"*** and default password: ***"00000"***)

6. Afterwards choose new static IP-Configuration for your given network (see Figure 7). If you set the ***"DHCP"*** check box, the IP-Configuration may be accomplished by a DHCP server in the local network automatically.

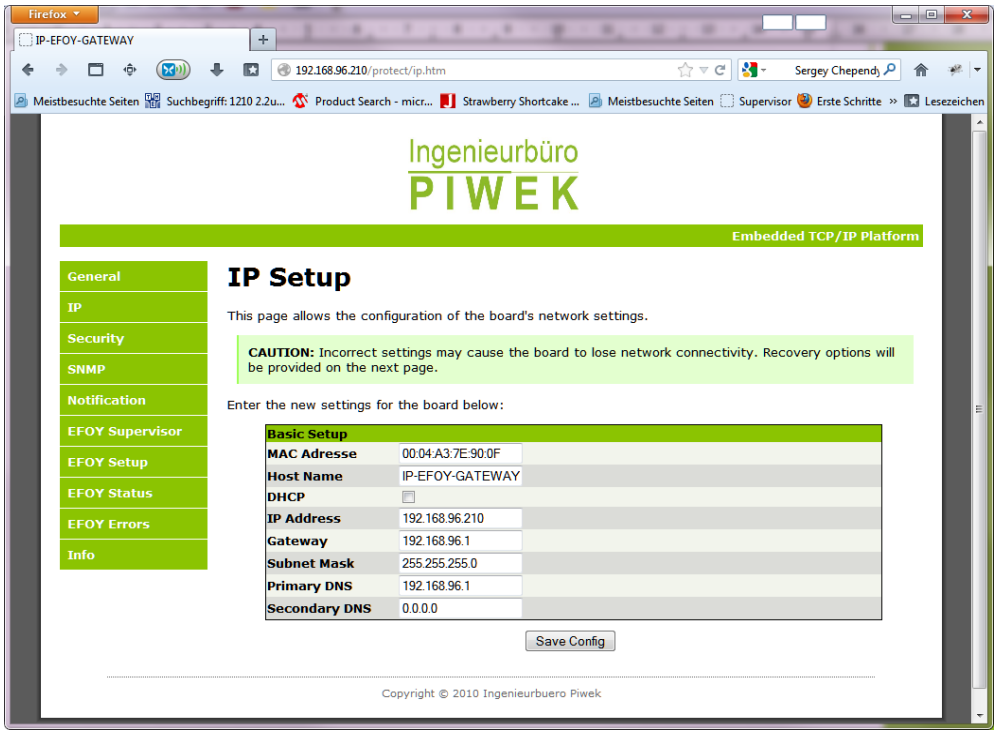

Figure 7: IP-Konfiguration IP-EFOY-GATEWAY

7. Now you may disconnect the network cable from your PC and reconnect it to a router or wireless router.
8. Now please open your browser again and enter the IP-EFOY-GATEWAY's IP-Address previously configured under item 6
9. Now you should have access to the web server over your local network

9 Use-Case

9.1 „Green“ Off-Grid 48V „Power Over Ethernet“ power supply for wireless base stations

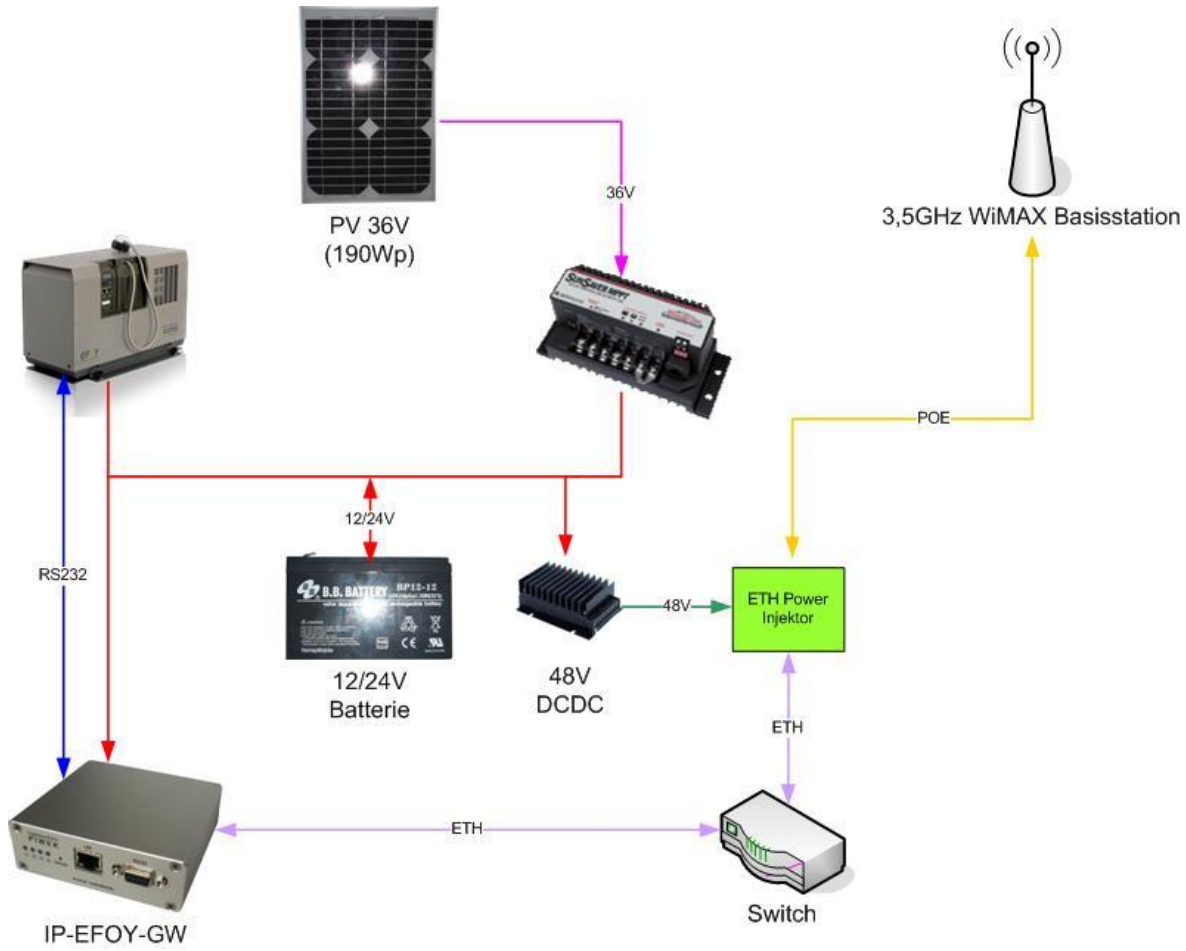

Figure 8: Green Power Supply

9.2 Portable EFOY Pro power supply with UMTS-Router for remote control applications

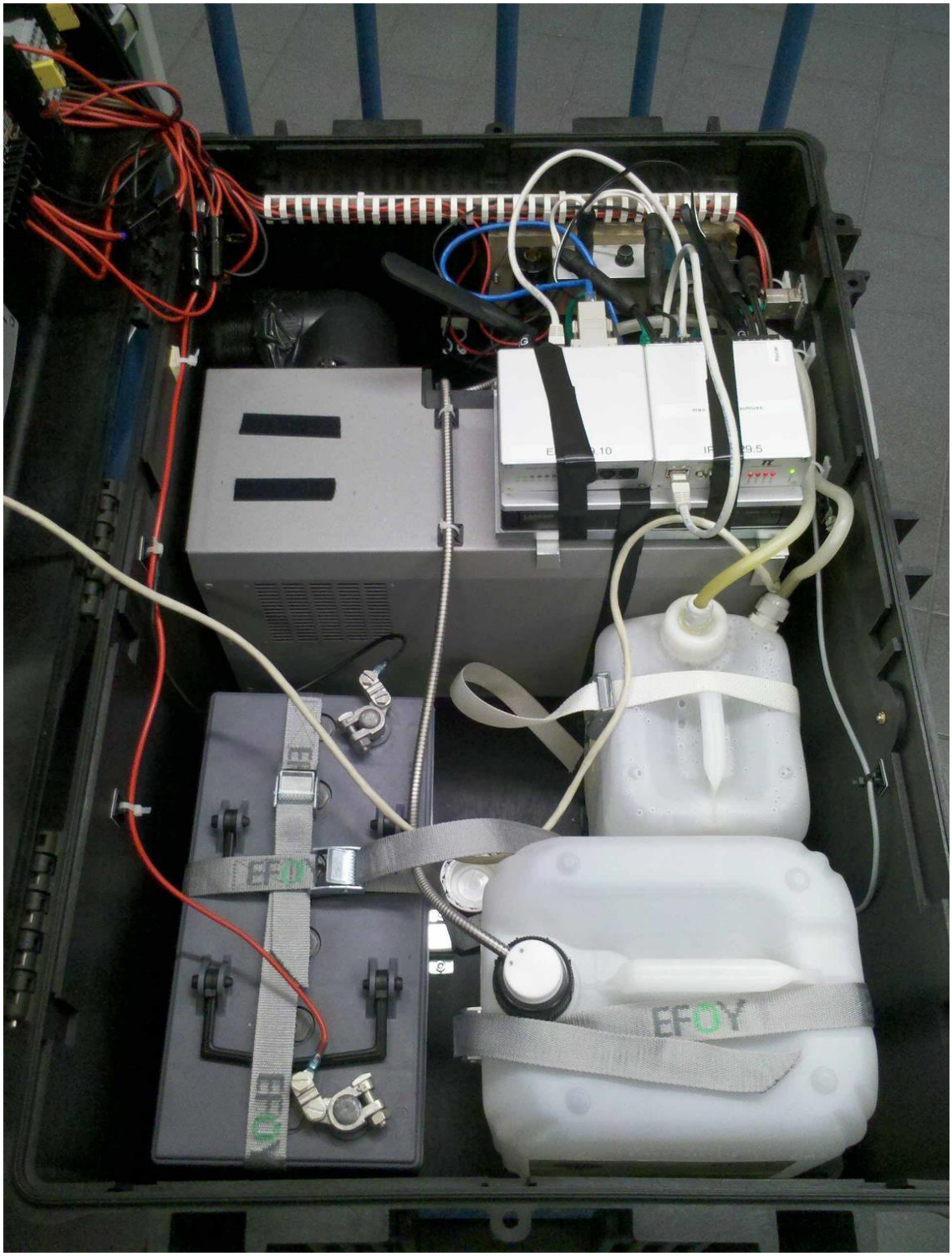

Figure 9: Fuel cell power supply for portable applications

9.3 Off grid power supply for wireless internet service provider (3.5 / 5 GHz base stations)

Figure 10: Pilot project - Off grid power supply for internet service provider

10 Description web interface

10.1 Web site - General

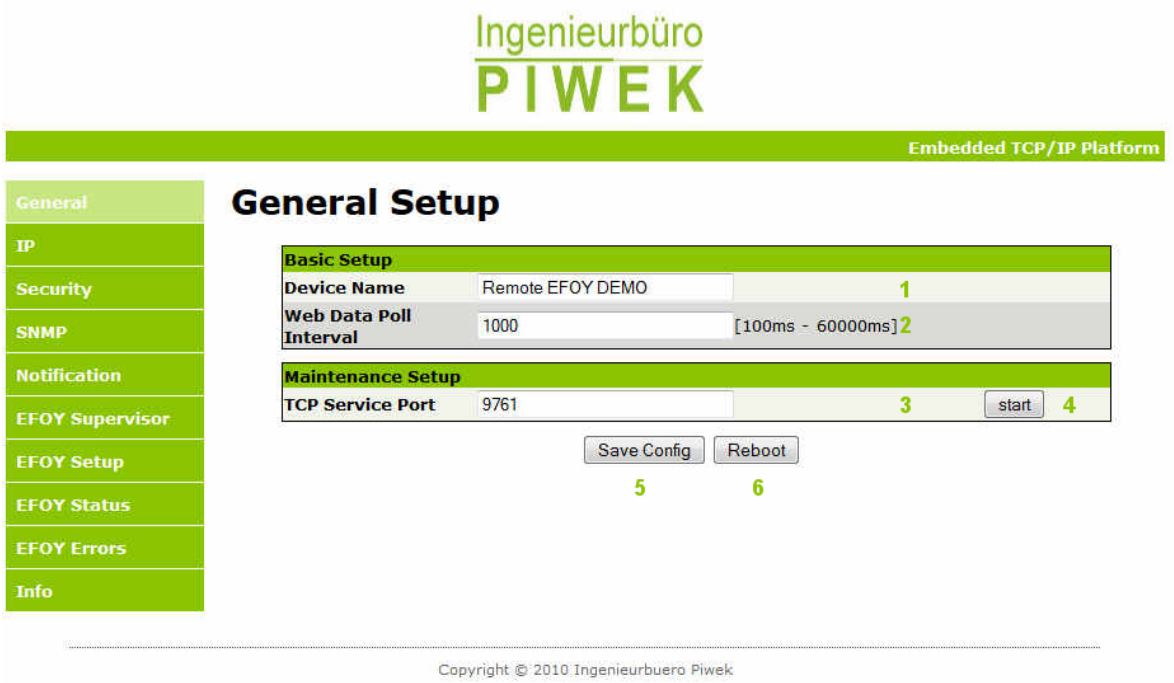

Figure 11: Web site - General

Note	Description
1	• Device name • name will be used by the email notification service
2	• Web data poll interval for dynamic data on web site in milliseconds
3	• Port for TCP-UART-BRIDGE-MODE (1024-65535)
4	• Start/Stop TCP-UART-BRIDGE-MODE
5	• Save settings
6	• IP-EFOY-GATEWAY restart

Table 10: Description web site - General

10.2 Web site – IP

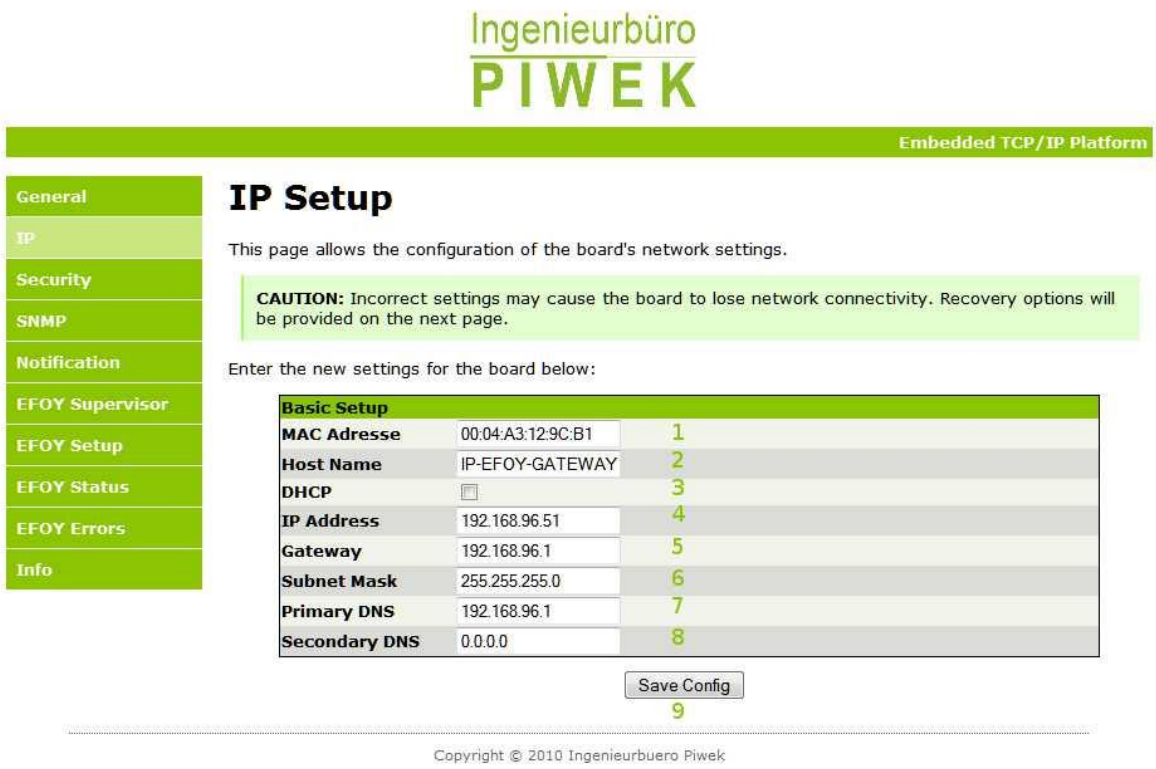

Figure 12: Web site - IP

Note	Description
1	• MAC address IP-EFOY-GATEWAY
2	• Host name IP-EFOY-GATEWAY
3	• DHCP client service enabled/disabled
4	• IP address IP-EFOY-GATEWAY (automatic bound via DHCP)
5	• Gateway in LAN (automatic bound via DHCP)
6	• Subnet mask (automatic bound via DHCP)
7	• Primary DNS Server (automatic bound via DHCP)
8	• Secondary DNS Server (automatic bound via DHCP)
9	• Save settings

Table 11: Description web site – IP

10.3 Web site - Security

Figure 13: Web site - Security

Note	Description
1	• User name
2	• Password(maximum 9 signs)
3	• Password confirmation
4	• Save settings

Table 12: Description web site – Security

10.4 Web site - SNMP

Figure 14: Web site - SNMP

Note	Description
1	• System name (may be readout via SNMP default OID)
2	• System location (may be readout via SNMP default OID)
3	• System contact (may be readout via SNMP default OID)
4	• Community name for read SNMP values (OIDs)
5	• Community Name for write SNMP values (OIDs) currently not used
6	• Save settings

Table 13: Description web site – SNMP

10.5 Web site - EFOY Supervisor

The EFOY Supervisor overview gives the customer further configuration and remote control opportunities as well. Some options differ from 1st to 2nd EFOY PRO generation.

- EFOY PRO restart
- EFOY PRO default settings
- EFOY PRO display language
- EFOY PRO error list

Figure 15: Web site - 1st generation EFOY Supervisor

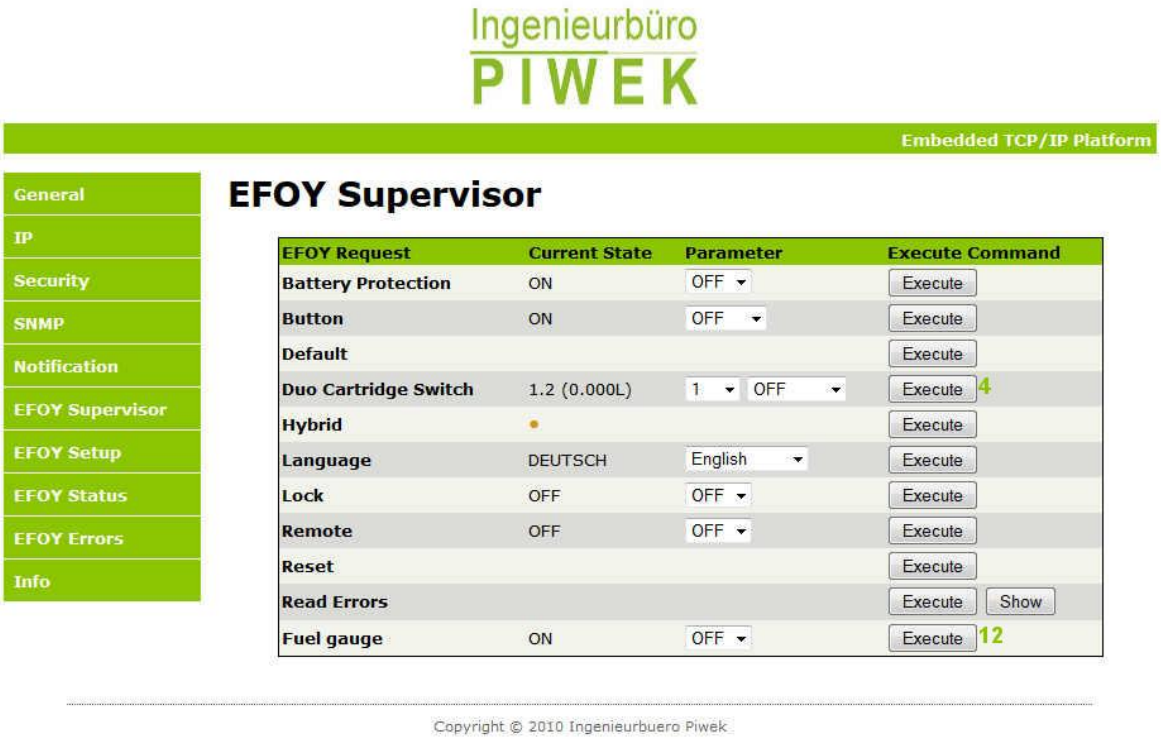

Figure 16: Web site - 2nd generation EFOY Supervisor

Note	Description
1	• Battery protection – nevertheless the EFOY will charge the battery if the battery voltage fall below the configured voltage and the EFOY operating mode is set to “OFF”, to prevent deep discharge
2	• Selection of EFOY operating mode
3	• Set default settings
4	• Switch duo cartridge switch (different options for 1st and 2nd EFOY PRO generation)
5	• Switch to hybrid mode
6	• Language selection for EFOY control panel
7	• lock configuration via control panel
8	• Switch to remote mode
9	• Restart EFOY
10	• Read EFOY Errors
11	• Display EFOY errors on web site (link to EFOY Errors menu item)
12	• Fuel gauge (just supported by 2nd EFOY PRO generation)

Table 14: Description web site - EFOY Supervisor

10.6 Web site - EFOY Setup

The EFOY setup overview makes it possible to set up EFOY PRO fuel cell's configuration. The entire configuration is described analogue to the EFOY “Config” request. Some options differ from 1st to 2nd EFOY PRO generation.

The table is arranged as follows:

- The first column shows the given parameter
- The second column shows the current parameter value
- The third column shows an empty text box, to update the parameter value
- The fourth column shows the default parameter value
- The fifth column shows the accepted parameter value range

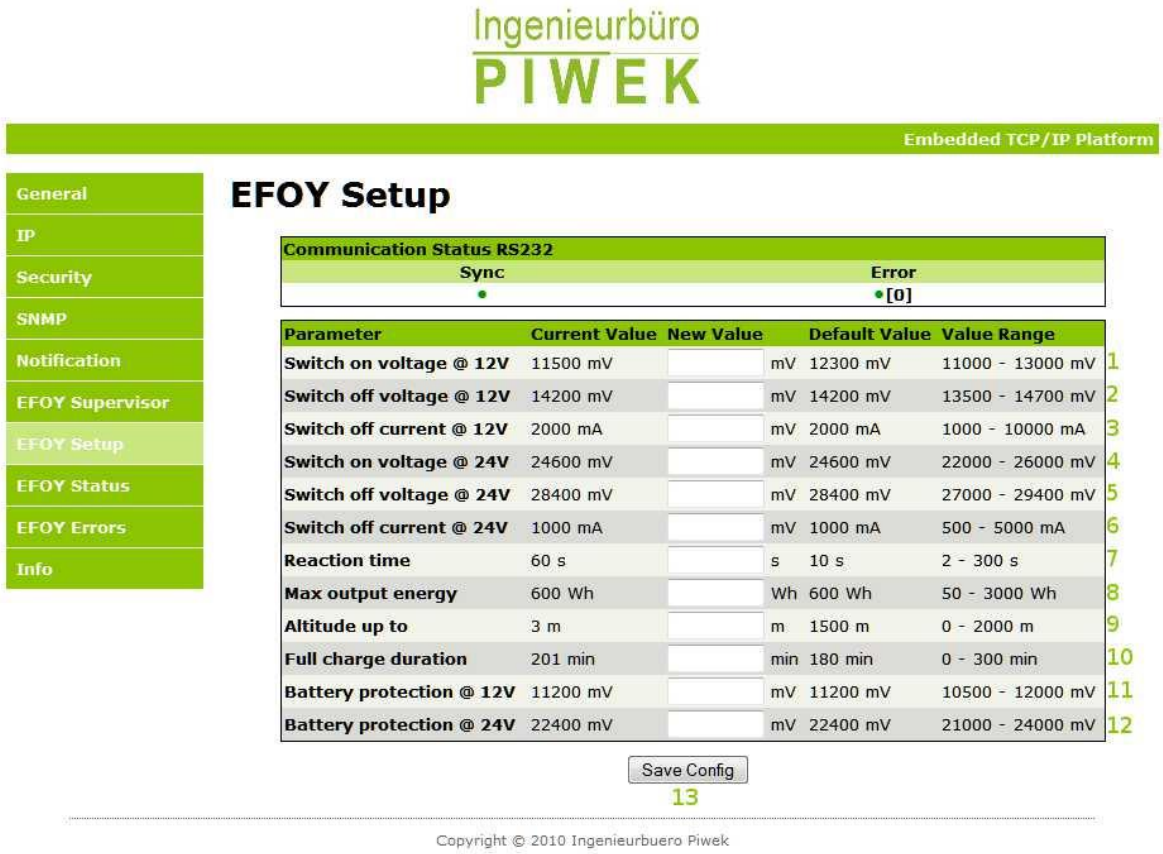
Ingenieurbüro
PIWEK
Embedded TCP/IP Platform
General
IP
Security
SNMP
Notification
EFOY Supervisor
EFOY Setup
EFOY Status
EFOY Errors
Info
EFOY Setup
Communication Status RS232
Sync
Error
[0]
Parameter | Current Value | New Value | | Default Value | Value Range
Switch on voltage @ 12V | 11500 mV | mV | 12300 mV | 11000 - 13000 mV | 1
Switch off voltage @ 12V | 14200 mV | mV | 14200 mV | 13500 - 14700 mV | 2
Switch off current @ 12V | 2000 mA | mV | 2000 mA | 1000 - 10000 mA | 3
Switch on voltage @ 24V | 24600 mV | mV | 24600 mV | 22000 - 26000 mV | 4
Switch off voltage @ 24V | 28400 mV | mV | 28400 mV | 27000 - 29400 mV | 5
Switch off current @ 24V | 1000 mA | mV | 1000 mA | 500 - 5000 mA | 6
Reaction time | 60 s | s | 10 s | 2 - 300 s | 7
Max output energy | 600 Wh | Wh | 600 Wh | 50 - 3000 Wh | 8
Altitude up to | 3 m | m | 1500 m | 0 - 2000 m | 9
Full charge duration | 201 min | min | 180 min | 0 - 300 min | 10
Battery protection @ 12V | 11200 mV | mV | 11200 mV | 10500 - 12000 mV | 11
Battery protection @ 24V | 22400 mV | mV | 22400 mV | 21000 - 24000 mV | 12
Save Config
13
Copyright © 2010 Ingenieurbuero Piwek

Figure 17: Web site – 1st generation EFOY Setup

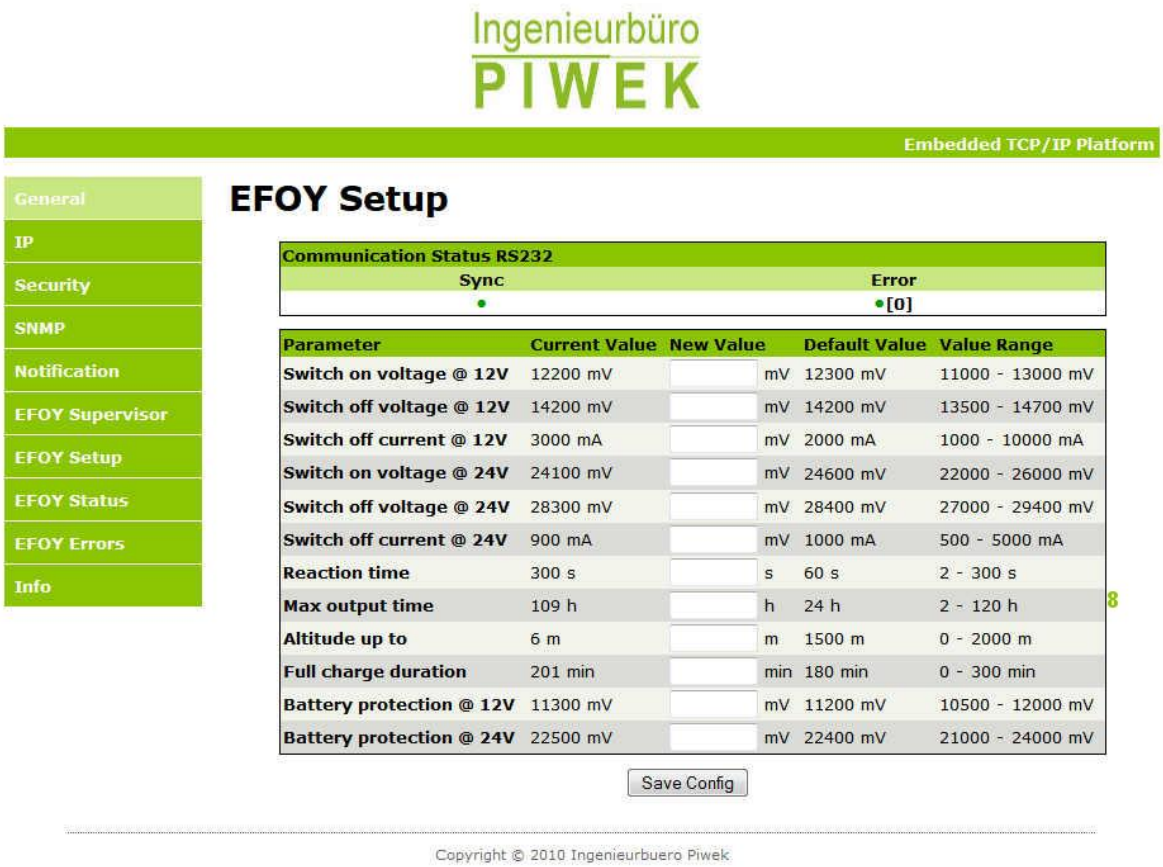
Ingenieurbüro
PIWEK
Embedded TCP/IP Platform
General
IP
Security
SNMP
Notification
EFOY Supervisor
EFOY Setup
EFOY Status
EFOY Errors
Info
EFOY Setup
Communication Status RS232
Sync
Error
[0]
Parameter
Current Value
New Value
Default Value
Value Range
Switch on voltage @ 12V 12200 mV mV 12300 mV 11000 - 13000 mV
Switch off voltage @ 12V 14200 mV mV 14200 mV 13500 - 14700 mV
Switch off current @ 12V 3000 mA mV 2000 mA 1000 - 10000 mA
Switch on voltage @ 24V 24100 mV mV 24600 mV 22000 - 26000 mV
Switch off voltage @ 24V 28300 mV mV 28400 mV 27000 - 29400 mV
Switch off current @ 24V 900 mA mV 1000 mA 500 - 5000 mA
Reaction time 300 s s 60 s 2 - 300 s
Max output time 109 h h 24 h 2 - 120 h
Altitude up to 6 m m 1500 m 0 - 2000 m
Full charge duration 201 min min 180 min 0 - 300 min
Battery protection @ 12V 11300 mV mV 11200 mV 10500 - 12000 mV
Battery protection @ 24V 22500 mV mV 22400 mV 21000 - 24000 mV
Save Config
Copyright © 2010 Ingenieurbuero Piwek

Figure 18: Web site – 2nd generation EFOY Setup

Note	Description
1	• EFOY switch on voltage for 12V systems in mV
2	• EFOY switch off voltage for 12V systems in mV
3	• EFOY switch off voltage 12V systems in mA
4	• EFOY switch on voltage for 24V systems in mV
5	• EFOY switch off voltage for 24V systems in mV
6	• EFOY switch off voltage 24V systems in mA
7	• Reaction time in seconds
8	• Maximum EFOY output energy in Wh (for 1st EFOY PRO generation) • Maximum output time in hours (for 2nd EFOY PRO generation)
9	• Altitude above Null in meter
10	• Maximum charge time duration in minutes
11	• Battery deep discharge threshold for 12V systems in mV
12	• Battery deep discharge threshold for 24V systems in mV

Table 15: Description web site - EFOY Setup

10.7 Web site - EFOY Status

The EFOY Status overview makes it possible to see the configuration of the EFOY PRO fuel cell. All values are updated dynamically and are displayed at a glance.

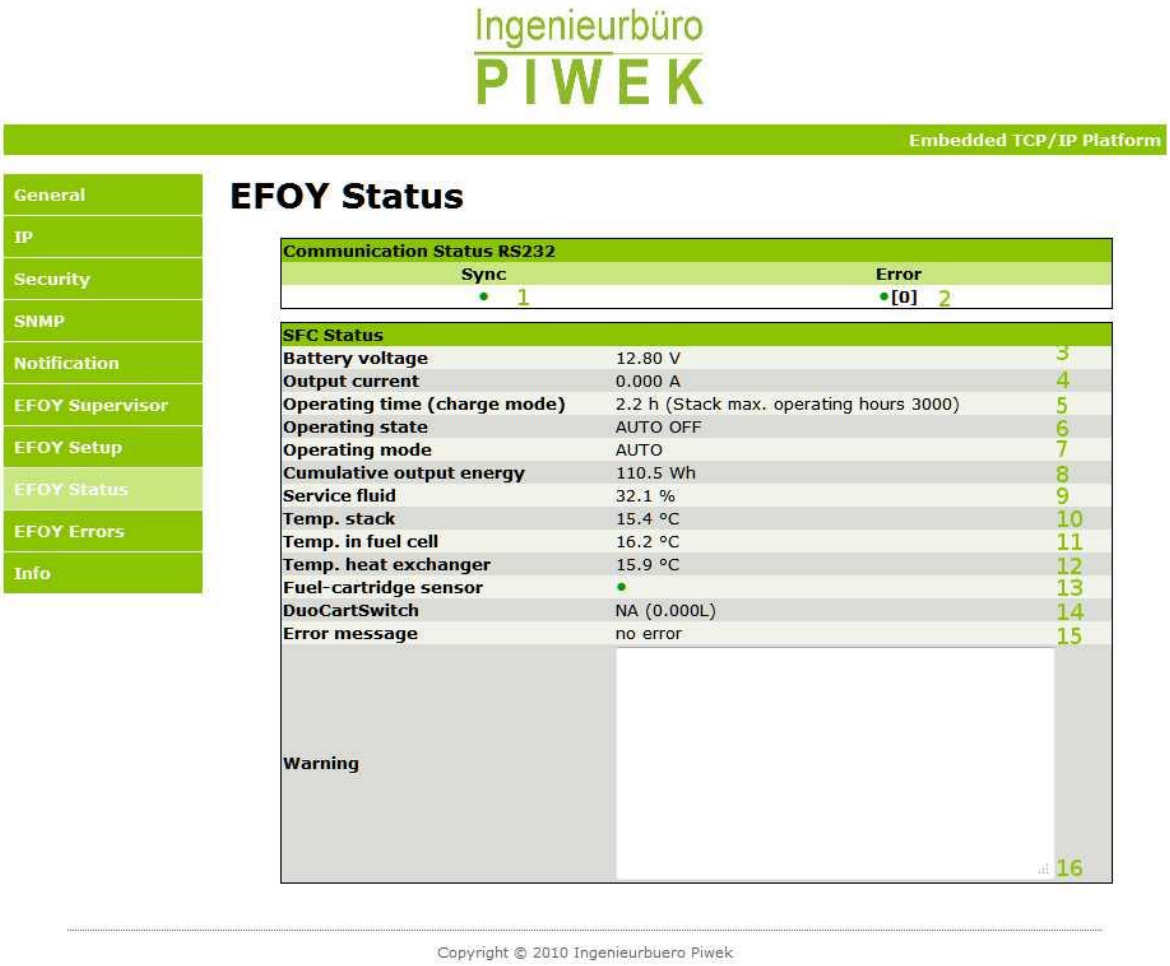

Figure 19: Web site - EFOY Status

Note	Description
1	• Green = IP-EFOY-GATEWAY synchronized with EFOY • Red = IP-EFOY-GATEWAY not synchronized with EFOY
2	• Green = IP-EFOY-GATEWAY no errors on processing EFOY data • Red = IP-EFOY-GATEWAY errors on processing EFOY data
3	• Current EFOY battery voltage in V
4	• Current EFOY charging current in A
5	• EFOY operating hours in charge mode with additional specification of warranted operating hours for the given EFOY fuel cell
6	• Current EFOY operating state
7	• Set EFOY operating mode
8	• Cumulative output energy
9	• Service fluid level

Note	Description
10	• Temperature at the stack
11	• Temperature in the fuel cell
12	• Temperature at the heat exchanger
13	• Green = methanol level above sensor threshold or no sensor connected • Red = methanol level below sensor threshold
14	• DuoCartSwitch state
15	• EFOY error message
16	• EFOY warning message

Table 16: Description web site - EFOY Status

10.8 Web site - EFOY Errors

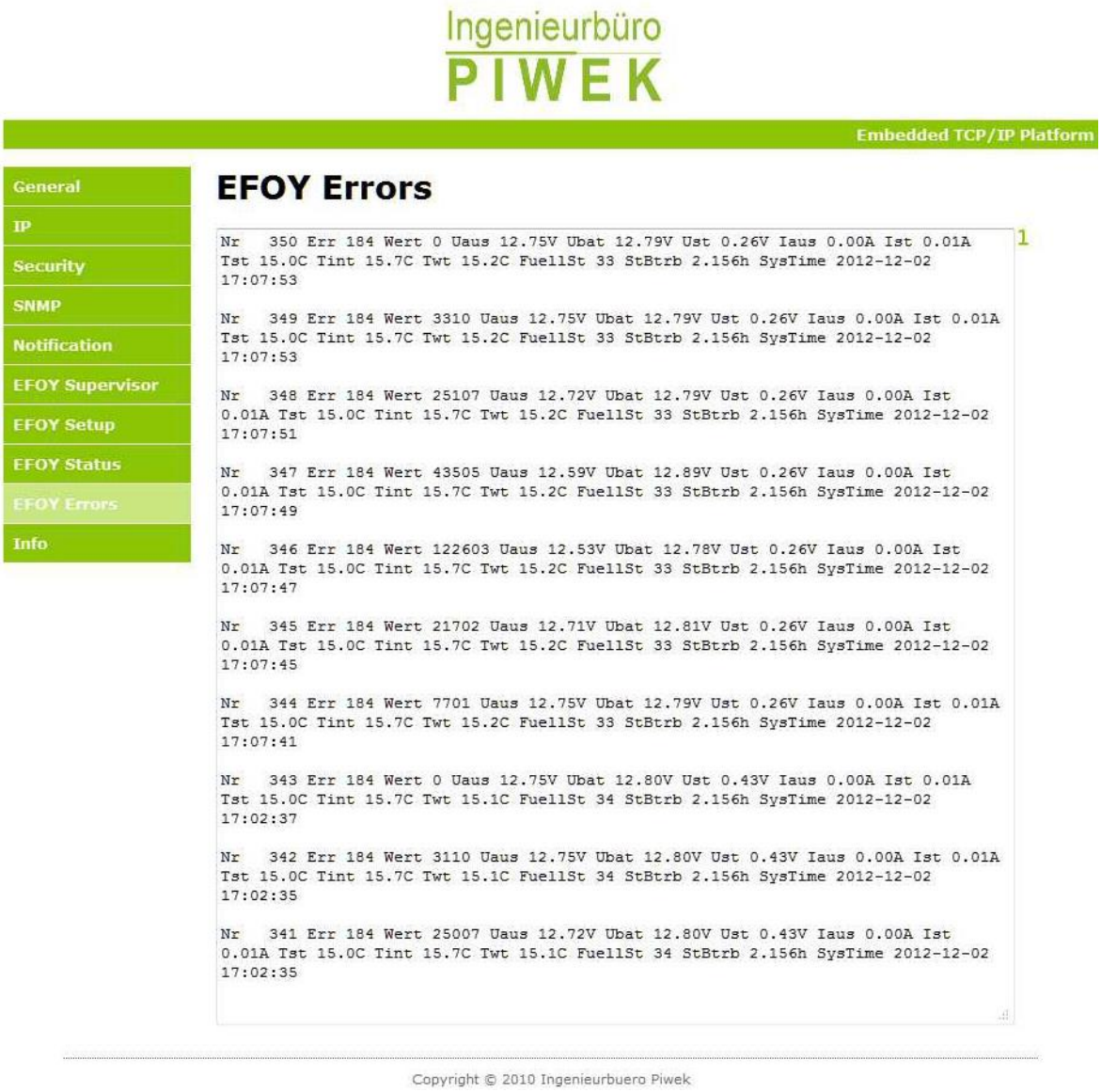
Ingenieurbüro
PIWEK
Embedded TCP/IP Platform
General
IP
Security
SNMP
Notification
EFOY Supervisor
EFOY Setup
EFOY Status
EFOY Errors
Info
EFOY Errors
1
Nr 350 Err 184 Wert 0 Uaus 12.75V Ubat 12.79V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:53
Nr 349 Err 184 Wert 3310 Uaus 12.75V Ubat 12.79V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:53
Nr 348 Err 184 Wert 25107 Uaus 12.72V Ubat 12.79V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:51
Nr 347 Err 184 Wert 43505 Uaus 12.59V Ubat 12.89V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:49
Nr 346 Err 184 Wert 122603 Uaus 12.53V Ubat 12.78V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:47
Nr 345 Err 184 Wert 21702 Uaus 12.71V Ubat 12.81V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:45
Nr 344 Err 184 Wert 7701 Uaus 12.75V Ubat 12.79V Ust 0.26V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.2C FuellSt 33 StBtrb 2.156h SysTime 2012-12-02 17:07:41
Nr 343 Err 184 Wert 0 Uaus 12.75V Ubat 12.80V Ust 0.43V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.1C FuellSt 34 StBtrb 2.156h SysTime 2012-12-02 17:02:37
Nr 342 Err 184 Wert 3110 Uaus 12.75V Ubat 12.80V Ust 0.43V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.1C FuellSt 34 StBtrb 2.156h SysTime 2012-12-02 17:02:35
Nr 341 Err 184 Wert 25007 Uaus 12.72V Ubat 12.80V Ust 0.43V Iaus 0.00A Ist 0.01A Tst 15.0C Tint 15.7C Twt 15.1C FuellSt 34 StBtrb 2.156h SysTime 2012-12-02 17:02:35
Copyright © 2010 Ingenieurbuero Piwek

Figure 20: Web site - EFOY Errors

Note	Description
1	EFOY error listing

Table 17: Description web site - EFOY Errors

10.9 Web site - Info

Figure 21: Web site – 1st generation EFOY Info

Figure 22: Web site – 2nd generation EFOY Info

Note	Description
1	• Device type IP-EFOY-GATEWAY
2	• Version firmware and hardware
3	• Version web site image
4	• Version TCP/IP Stack
5	• Compile date
6	• Link Web site Ingenieurbuero Piwek
7	• Link Email to Ingenieurbuero Piwek
8	• Connected EFOY will be determined automatically
9	• Firmware Version EFOY
10	• Serial no. EFOY
11	• Serial no. EFOY Stack
12	• Language selected in control panel

Table 18: Description web site – Info

10.10 Email Notification Service

From firmware versions **v0.6.1** on, the IP-EFOY-GATEWAY supports an email notification service to deliver EFOY PRO events and warnings to an email address. From now on service personnel get real-time email fault reports on their smart phone or email account. The service is set up the easy way over the website menu *"Notification"* (see Figure 22). The user just needs to have a valid email address and an email account login for the email server.

Figure 23: Website email notification

The following EFOY PRO events are delivered to the preconfigured email recipient via an email fault report (see 20).

EFOY PRO Parameter	Event description
Operating State	If error or off
Cartridge sensor	If cartridge below sensor level
Warning	if Warning message in memory
Service Fluid	If level <19%
Warranted operating hours	If warranted operating hours reached • EFOY PRO 600 -2200 → 3000 h • EFOY PRO 2200XT → 4500 h • EFOY PRO 800/2400 → 4500 h

Table 19: Notification event

In the following 21 the email notification configuration is described.

Field name	Description	Option
Notification Enabled	Enables the email notification service	mandatory
SMTP Server	SMTP server used for email delivery. Please consult your administrator or email provider.	mandatory
Port	Port number of the SMTP server. Please consult your administrator or email provider. By default port 25 should be set	mandatory
User	User name of the SMTP servers. Please consult your administrator or email provider.	optional
Password	Password of the SMTP servers. Please consult your administrator or email provider.	optional
To	Email address of the recipient. The right email format is checked on pressing save button. If it is incorrect, an pop-up window shows an error message.	mandatory
Save	Saves the configuration. Please use this button after finishing the email configuration.	optional
Send Test Message	After saving the configuration, you can generate a test email message by pressing this button. Use this way to check if emails are delivered correctly to the configured recipient. The head of the website shows a message if the email was delivered or not. (see Figure 24 and Figure 25)	optional

Table 20: Configuration fields Email notification

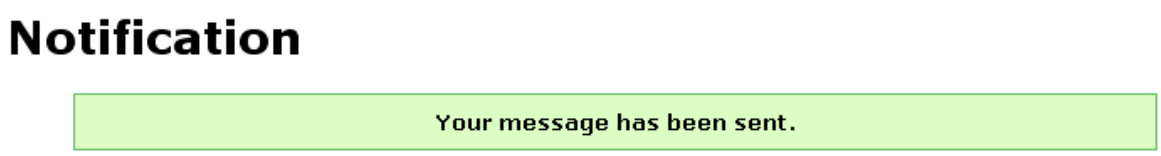

Figure 24: Email delivered successfully

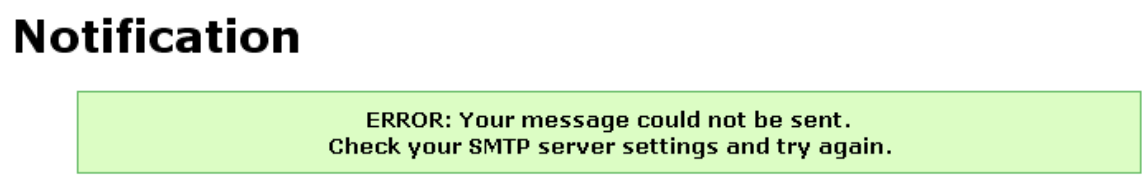

Figure 25: Email not delivered successfully

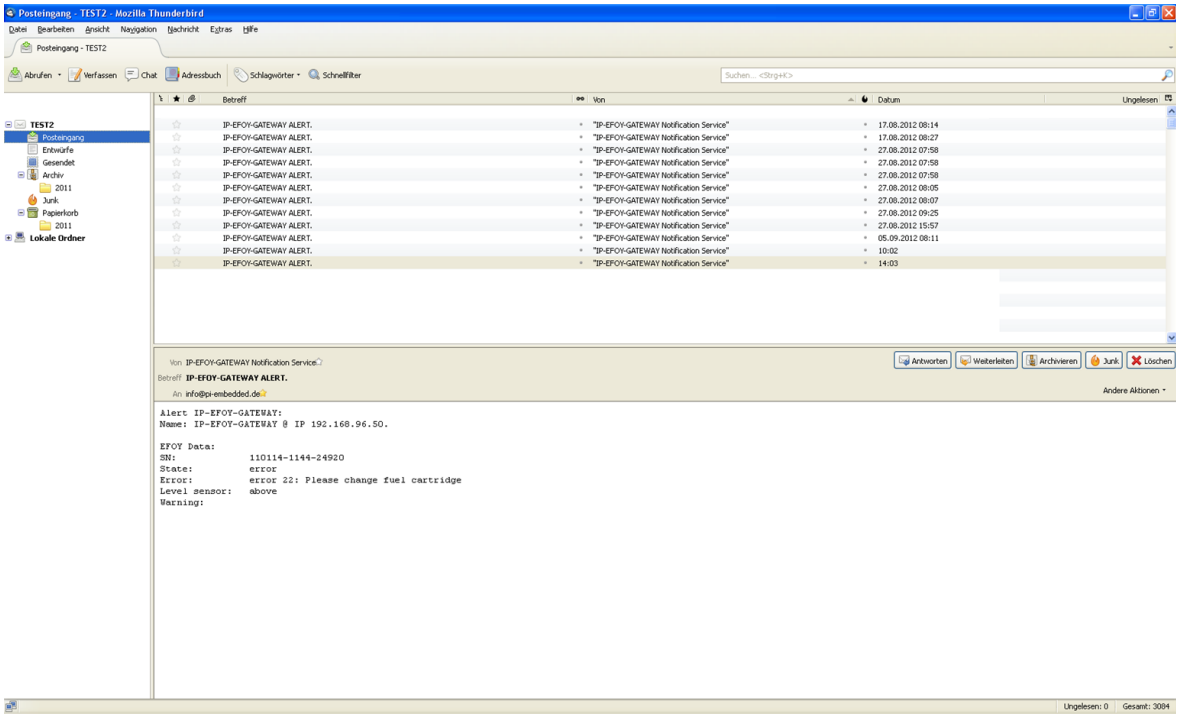

Figure 26: Email Client

Emails of the IP-EFOY-GATEWAY can be fetched with a default email client software like Microsoft Outlook, Mozilla Thunderbird (see 22) or a Smart-Phone.

Figure 27 depicts all fetched fault report emails in the area marked with ***„1“***. Area ***„2“*** shows the delivered IP-EFOY-GATEWAY emails with the fault report in more detail. 22 illustrates the email fields and the single rows of the fault report.

Email subject: *IP-EFOY-GATEWAY ALERT.*

Email from: *IP-EFOY-GATEWAY Notification Service*

Field name	Description
Name	Shows the name of the IP-EFOY-GATEWAY configured via the website menu ***„General“*** and the corresponding IP address.
SN	Serial number EFOY PRO
State	Operating State EFOY PRO
Op. Hours	Operating hours and warranted operating hours in charge mode
Service Fluid	Service fluid level in %
Error	Error message EFOY PRO, if failure occurs. Otherwise filled with ***„no error“***
Level sensor	State of the methanol cartridge sensor. If no methanol cartridge sensor is connected, this field is filled with ***„above“***. If it is connected and the fuel cell runs out of methanol, the field is filled with ***„below“***, otherwise with ***„above“***.
Warning	Warning message EFOY PRO, if a warning is occurred, otherwise this field is empty.

Table 21: Description event protocol

10.11 TCP-UART-BRIDGE-MODE

Remote control over a command line interface is also possible. Figure 26 depicts the opportunity how to establish a remote connection to the IP-EFOY-GATEWAY over terminal software like Hyper term, Tera term.

To use this option, a service (TCP Service Port) has to be started first over the web interface.

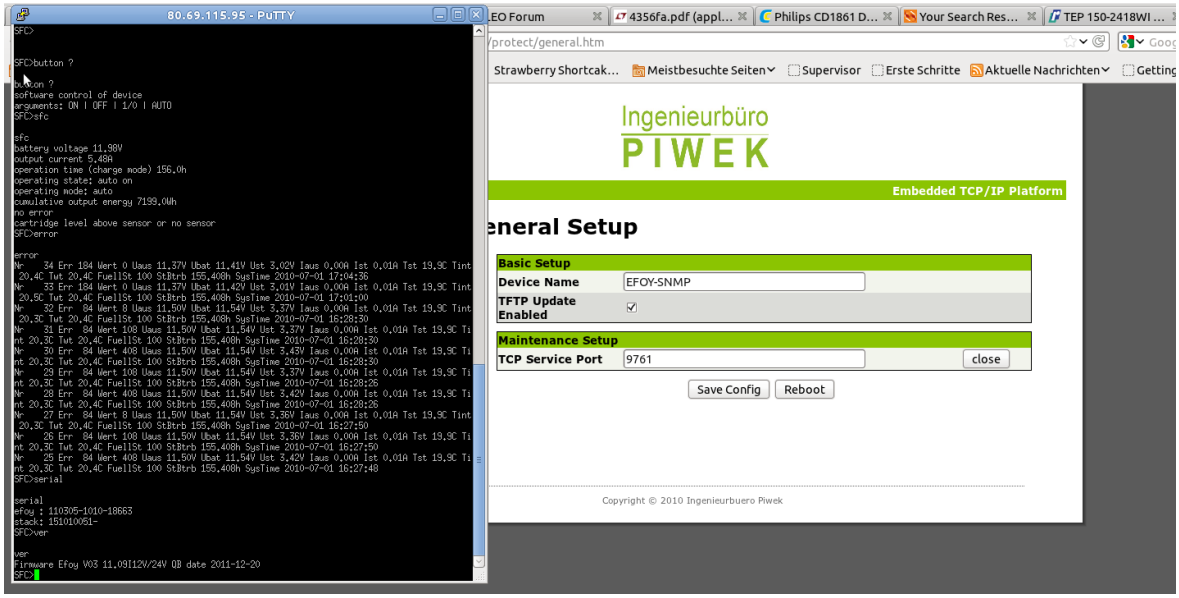

Figure 27: TCP-UART-BRIDGE-MODUS

10.12 Off-the-shelf SNMP based monitoring solution

Figure 27 shows customer's IP-EFOY-GATEWAY implementation using an SNMP based monitoring solution.

Doing so it is possible to manage all EFOY PRO installations at a glance. This solution is especially intended to be used by „blue light“ organizations, telecommunication provider, surveillance provider, as all critical IP data can be secured by the customer himself. So the customer doesn't rely on any third party portal solutions and security can be assured on demand.

The following network map shows a rough overview of the entire network infrastructure. I.e. the monitoring solution is not only intended to be used for IP-EFOY-GATEWAYs, also all other network equipment e.g. cameras, router, switch, server... can be monitored, in general all devices having an IP address and of course all products deployed by Ingenieurbüro Piwek.

If an EFOY PRO is in error state, or running out of methanol, the IP-EFOY-GATEWAY on the tactical map lights up red. The operator is now able to react very quickly within few minutes.

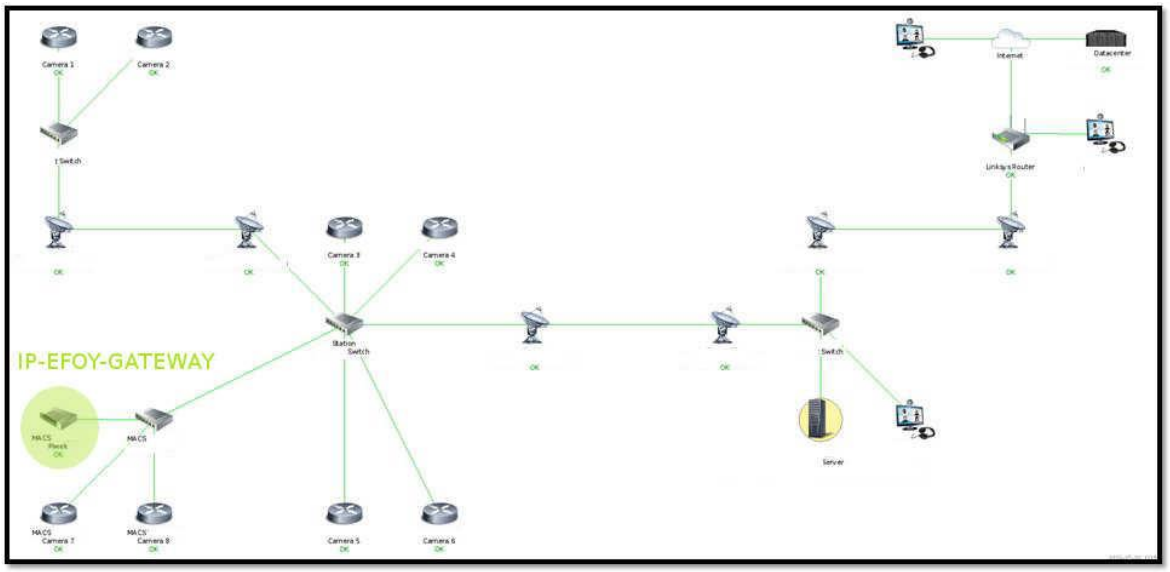

Figure 28: Tactical Network Map

Figure 29 shows additional EFOY PRO information in graphical charts. So you can see the entire fuel cell behaviour over time.

- Battery voltage
- Charging current
- Fluid level
- Output energy
- Temperatures stack, heat exchanger, fuel cell

EFOY Fuel Cell status on Piwek MACS
Piwek MACS: EFOY Battery Voltage in V (1d)
Piwek MACS: EFOY Charge Current in A (1d)
Piwek MACS: EFOY Battery Voltage and Current (1d)
Piwek MACS: EFOY Output Energy in Wh (1d)
Piwek MACS: EFOY Service Fluid Level in % (1d)
Piwek MACS: EFOY Temperatures in °C (1d)

Figure 29: Live EFOY PRO graphs overview

Customer's feedback:

Here's the host screen showing the voltage/current, output energy, service fluids and temperature levels.

In addition to these, we also read out the Cartridge Sensor and Error Messages. Based on the results we get via SNMP we added triggers for those. So whenever the fuel cell is in error or when the fuel drops below the sensor level, we get notified per e-mail.

Also, on the tactical map, the IP-EFOY-GATEWAY icon will light up and show the error. By doing so, our personnel can see which fuel cell is in error, what the cause is and what equipment is depending on the fuel cell.

And because we are graphing everything, we can estimate the time before the fuel levels are reaching critical conditions, as we have visual trends for the energy usage of our systems. So we even know how much time we have to remedy the situation and we can predict maintenance rounds to change the fuel cartridges. And it also helps us to calculate Service Level Agreements.

We are currently trying out that monitoring software in a special project for the Railroad, Railway Police and local Police for Crowd Management purposes.

10.13 SNMP EFOY PRO Fuel Cell Remote Control

Due to SNMP V2C network protocol support of the IP-EFOY-GATEWAY, the system is capable of providing a given set of variables called OIDs, reflecting the EFOY PRO fuel cell's state, to the customers network management system. Figure 30 shows a chart logged with a free network management system „The Dude“ over SNMP protocol. At this the blue curve reflects the EFOY PRO battery charging current and red curve reflects the EFOY PRO battery voltage. Furthermore it shows the charging/discharging intervals over the time in a detailed manner. Just due to this information the customer is able to react to any events coming up very quickly. In many network management systems events can be triggered

- If the battery voltage falls below a threshold or if the EFOY PRO runs out of methanol, a SMS or Email is sent to a service engineer
- If the EFOY PRO operating time exceeds 5000 hours, send an message to a service engineer for EFOY PRO maintenance

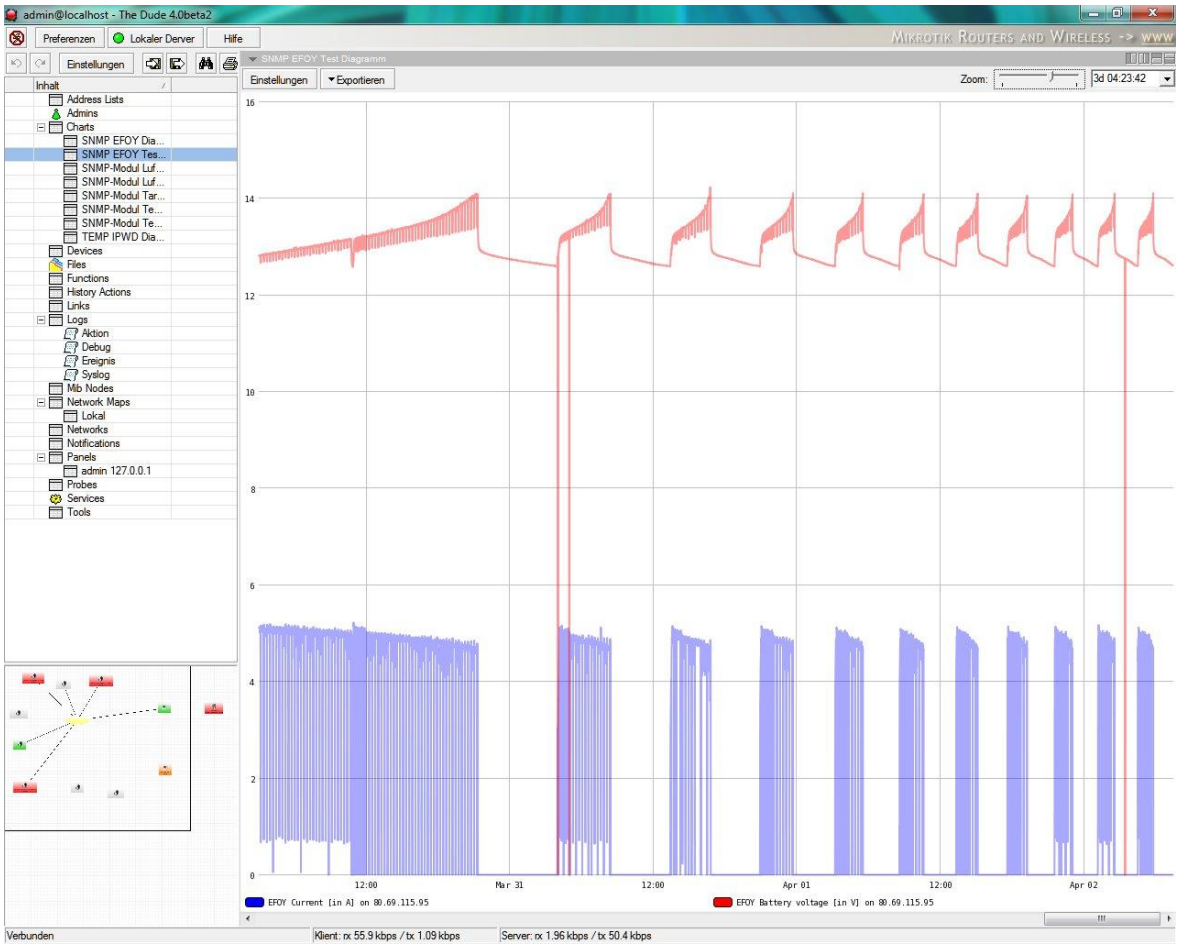

Figure 30: SNMP Chart